



CFD APPLICATIONS IN MARINE AND OFFSHORE INDUSTRY

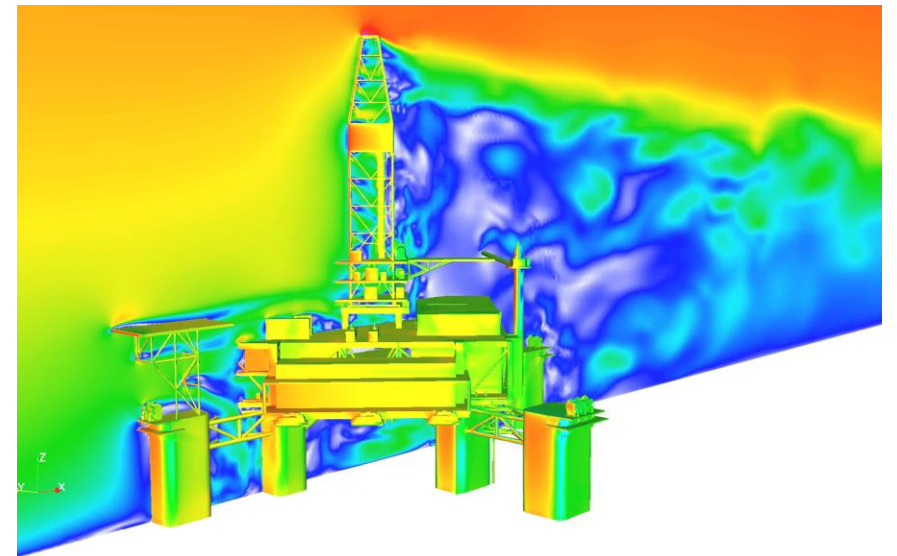
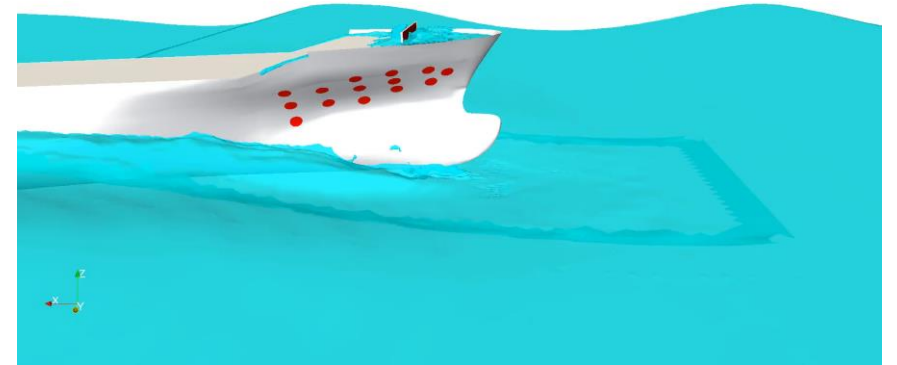
Zhirong Shen, Senior Engineer
4th CMHL Symposium | January 14, 2021



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Industrial Applications of CFD

- CFD technologies are increasingly applied in various industries from aerospace to automotive.
- In the Marine and Offshore Industry, CFD is becoming powerful design and assessment tool.
- However, challenges remain in industrial applications.



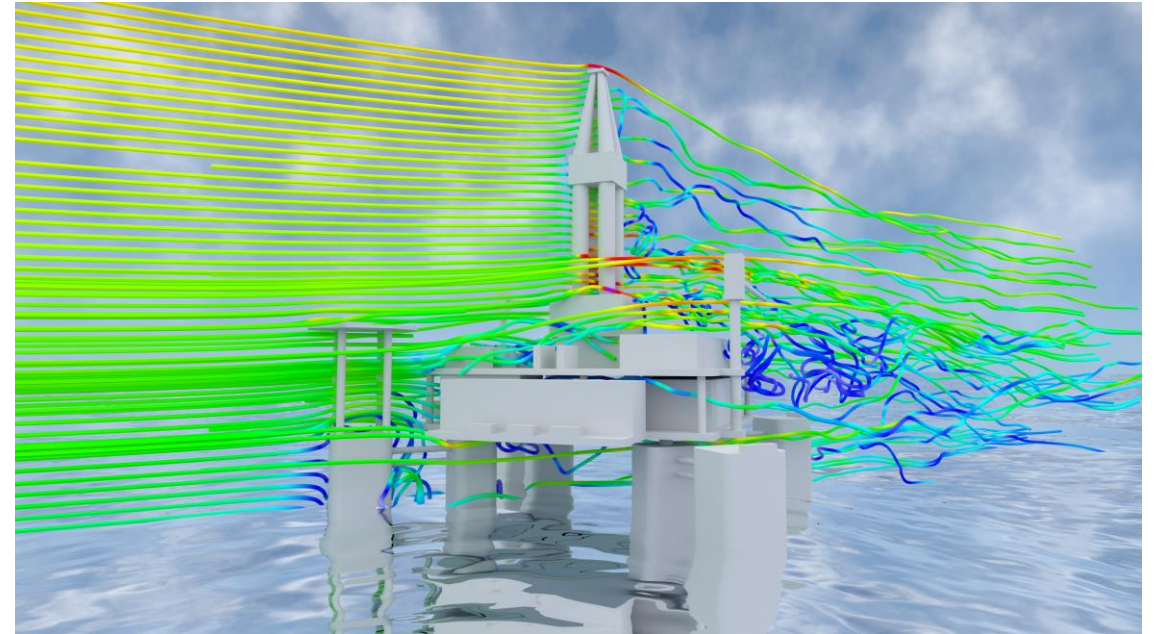
Industrial Applications of CFD

- **Challenges:**

- Efficiency
- Timing and schedule
- Hardware and licensing costs
- Quality control & quality assurance

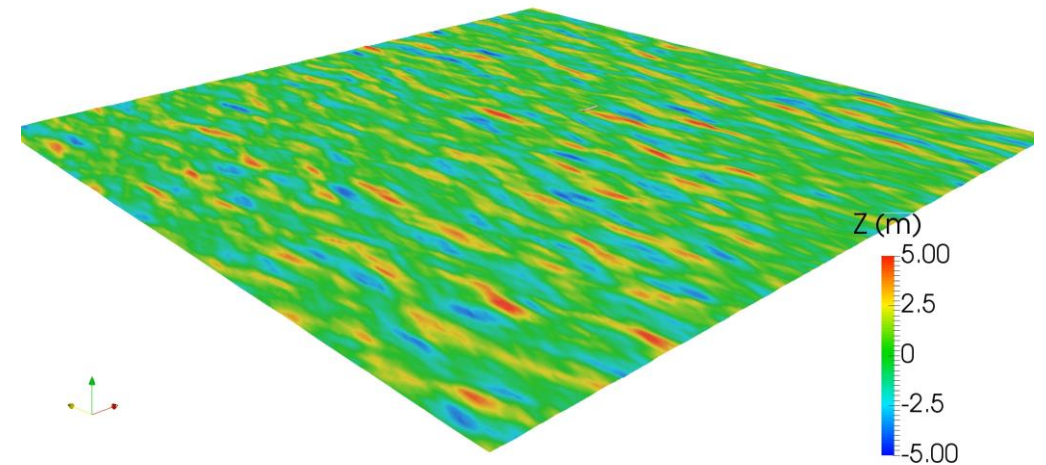
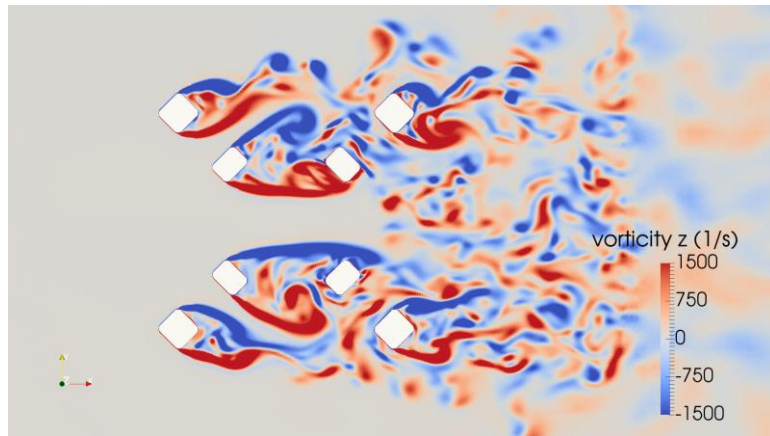
- **Solutions:**

- Joint Industry/Development Projects
- Rigorous modeling practices
- Automation
- Detailed planning

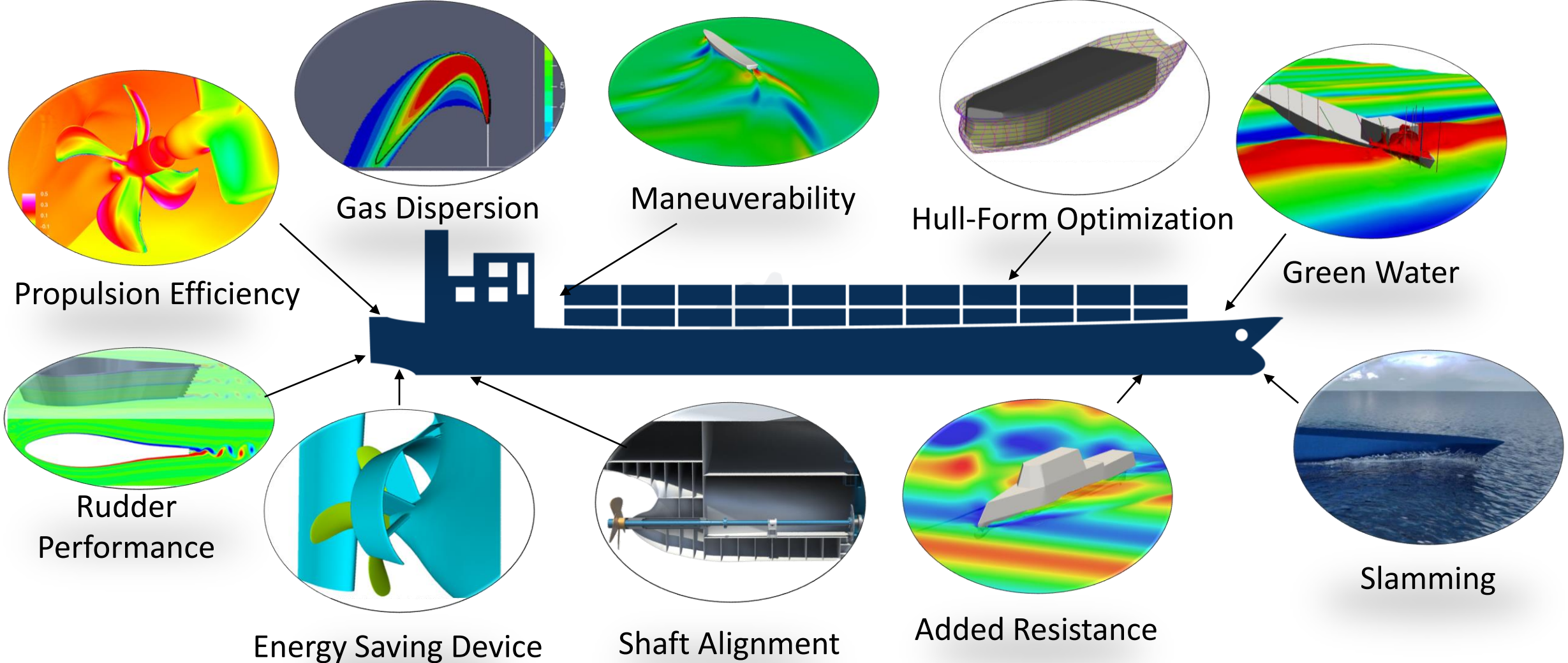


Industrial Applications of CFD

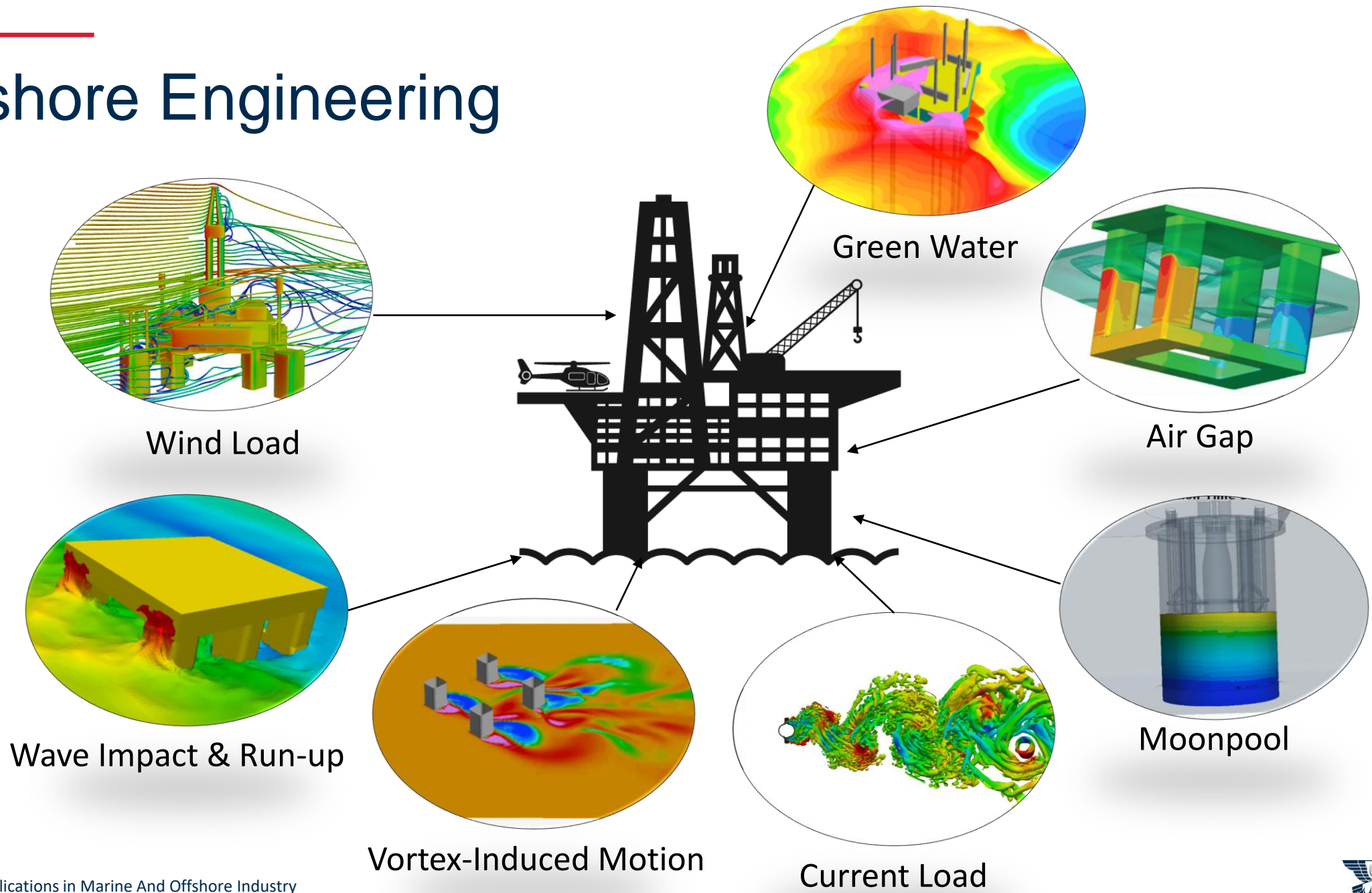
- ABS has been actively working on the CFD applications for industrial problems.
- Support our internal engineering departments and external clients
- Work closely with industrial partners in various JIPs and JDPs
- Build rigorous modeling practices for various applications



Marine Engineering



Offshore Engineering

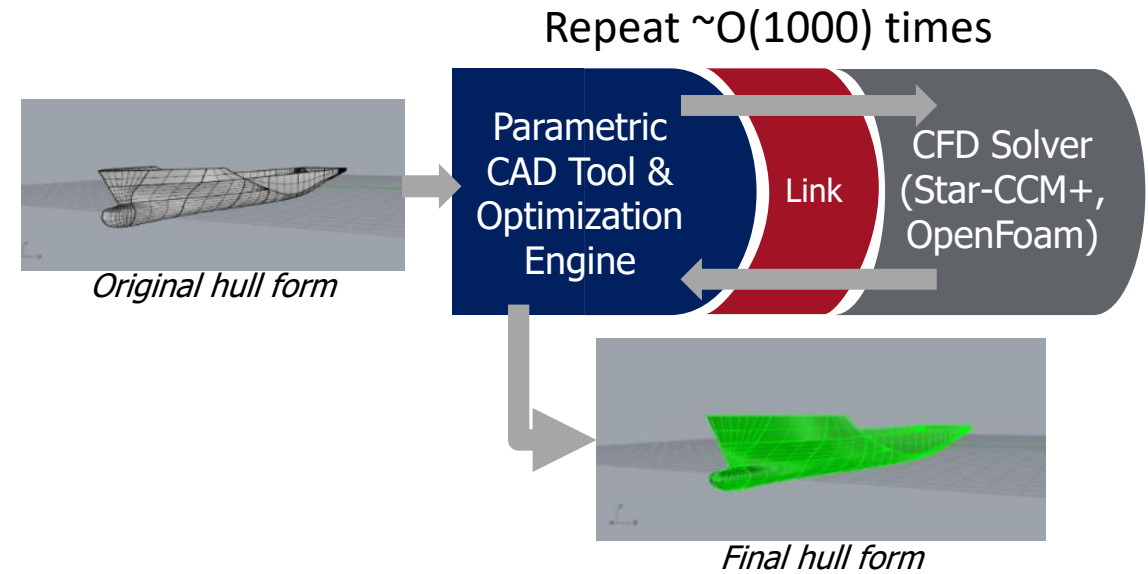


Applications in Marine Engineering



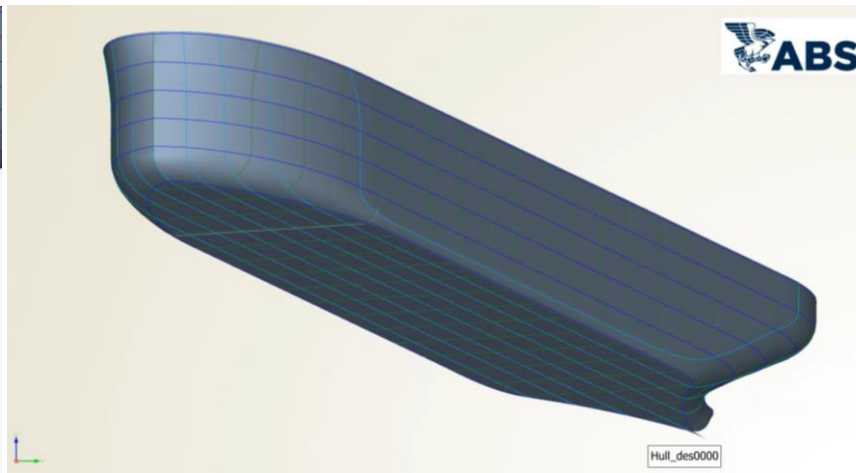
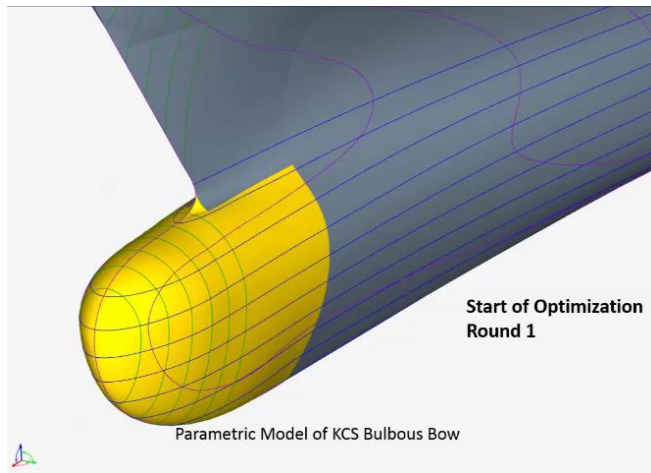
Hull-Form Optimization

- A highly automated optimization process based on CFD technologies
- Starting from a baseline, multiple rounds of optimization process are launched for the optimal design

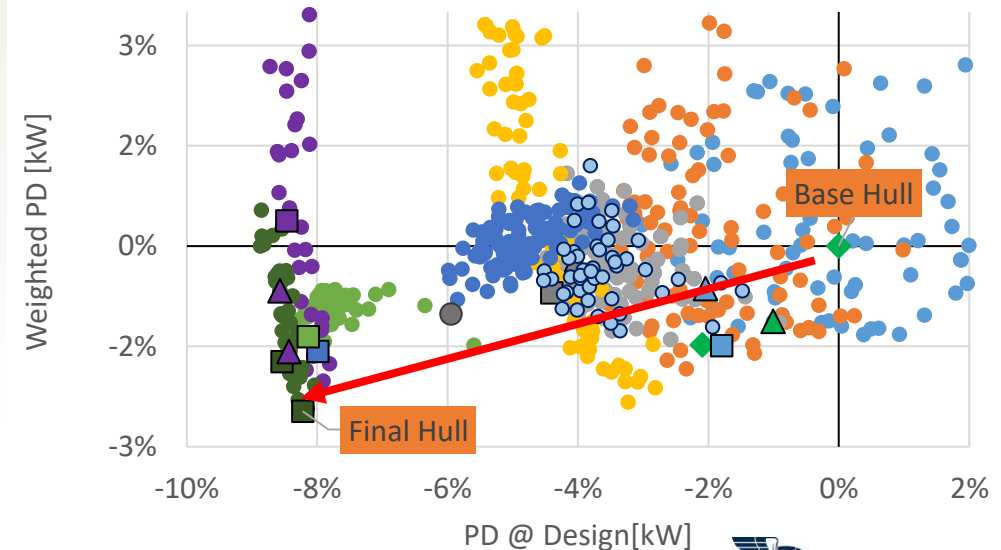


Local Optimization

Global Optimization

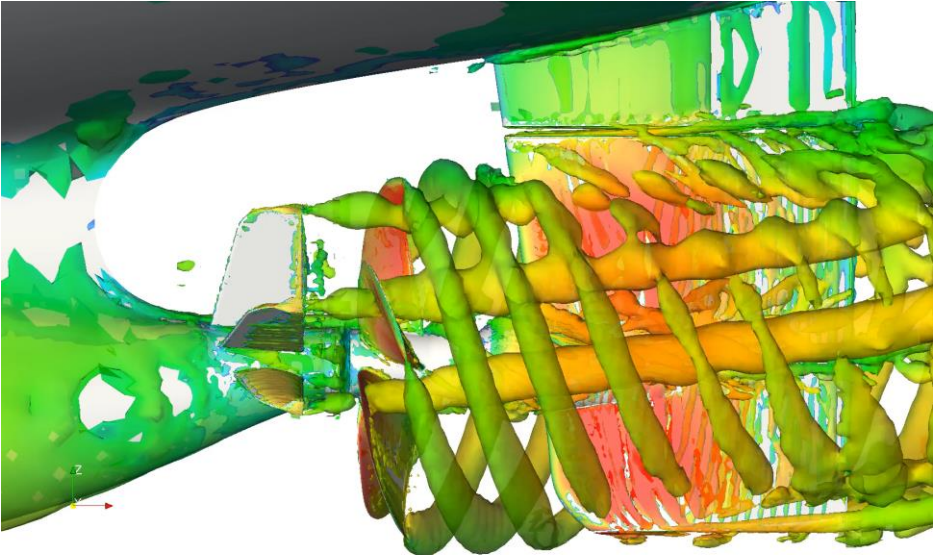
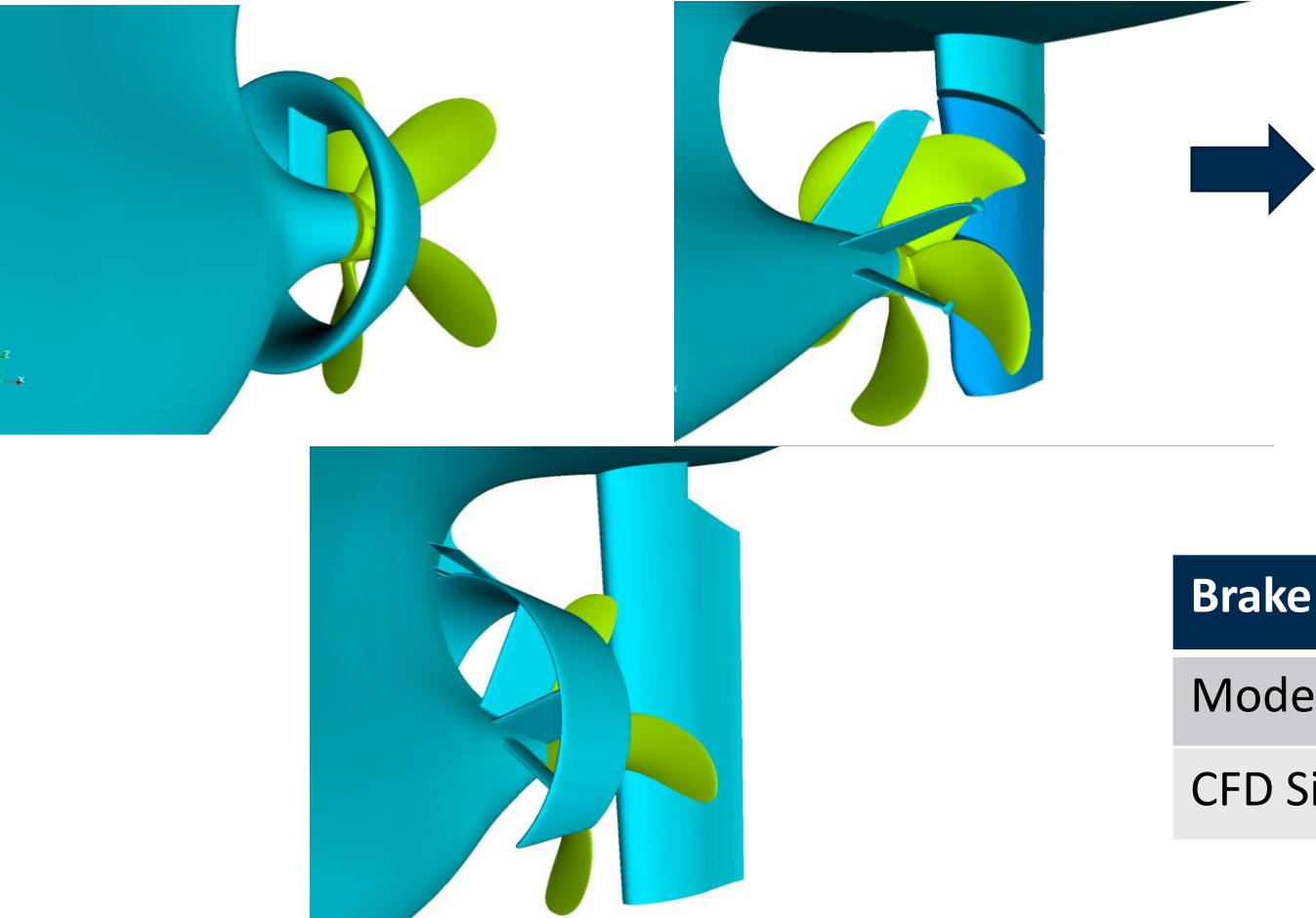


Searching the optimal design



Energy Saving Device (ESD)

Evaluate the effect of ESD on propulsion efficiency

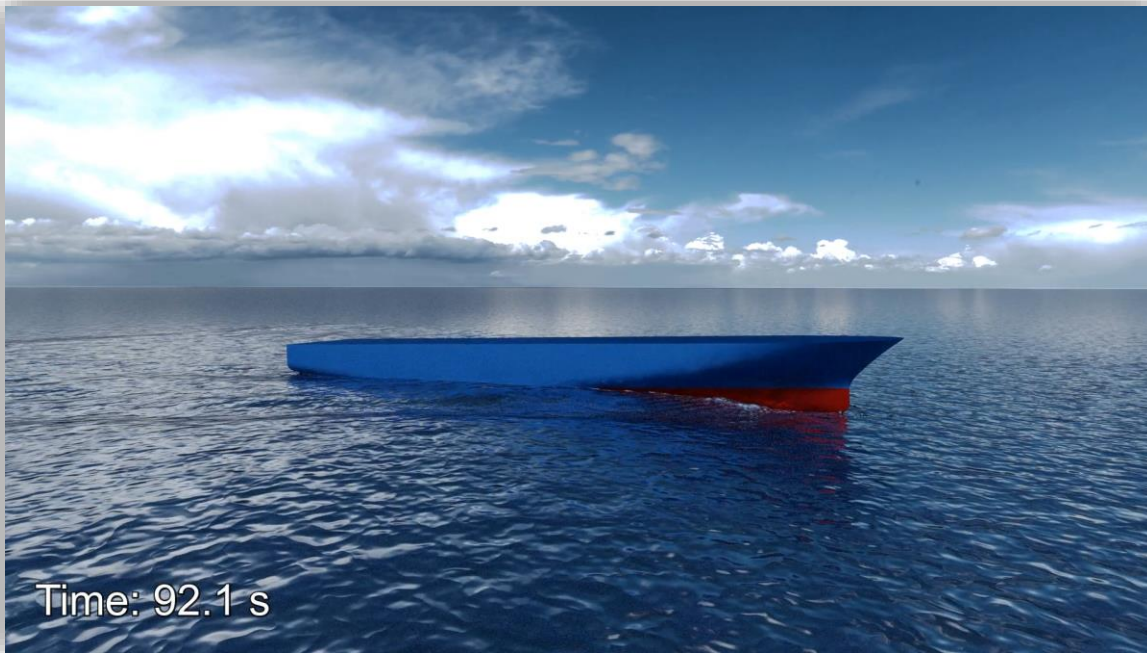


Brake Power [kW]	Without ESD	With ESD
Model Test Prediction	5.58×10^7	5.47×10^7
CFD Simulation	5.55×10^7	5.32×10^7

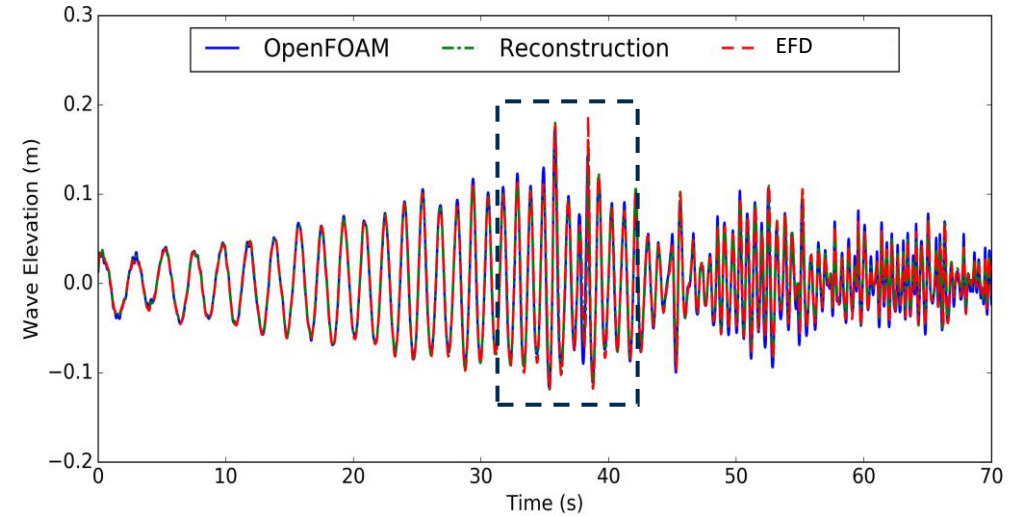
Reduced Power by 2~4%

Slamming Load Prediction

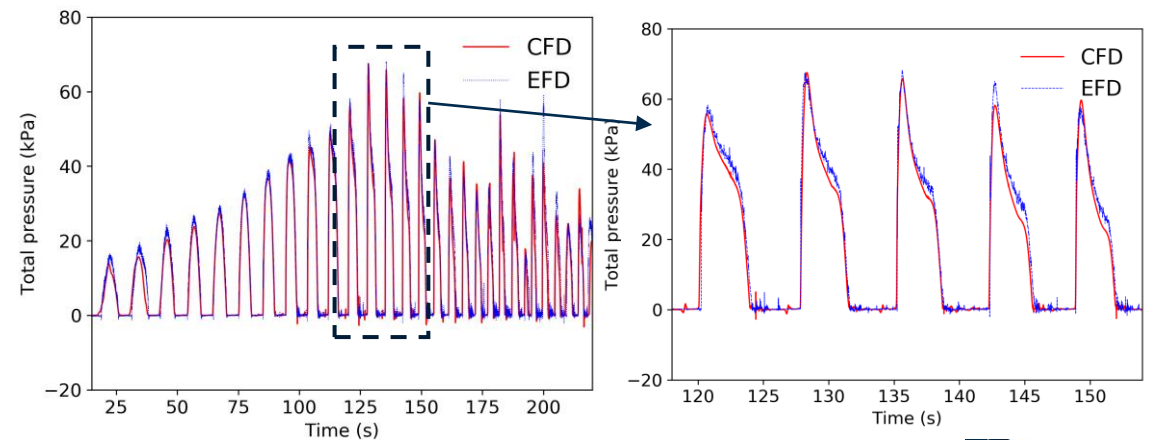
Slamming Simulation in CFD



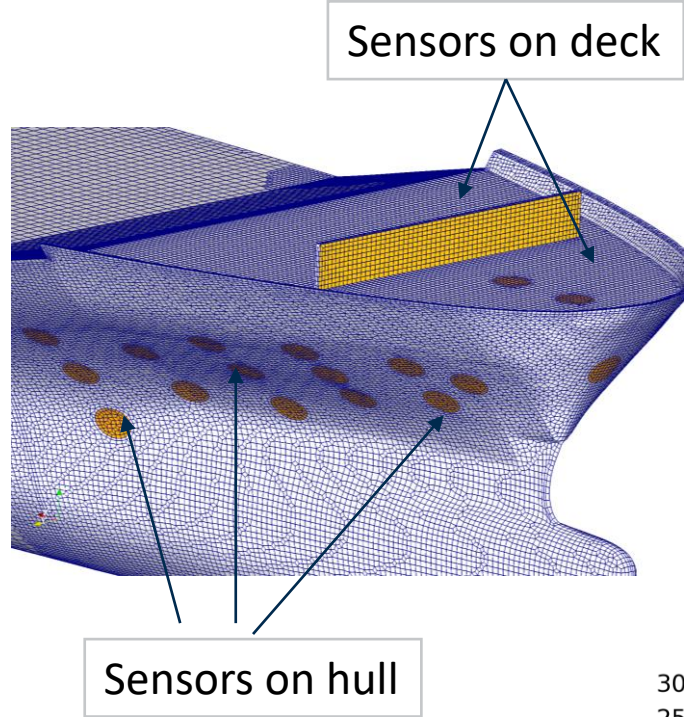
Reproduced Wave Signal in CFD (model scale)



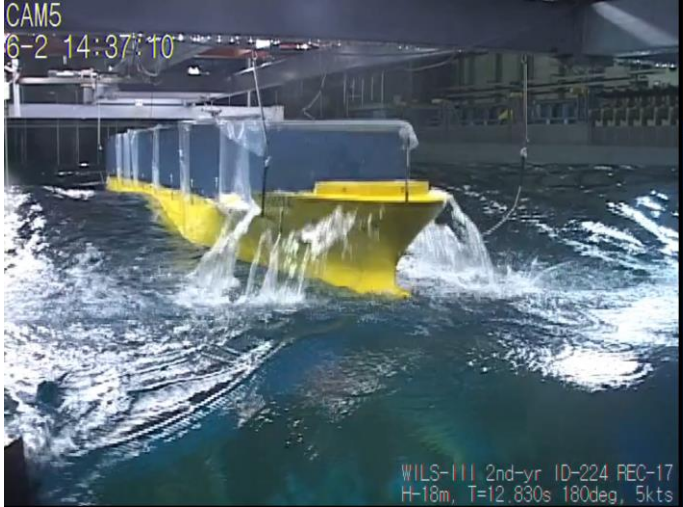
Slamming Loads Compared with Experiment (full scale)



Slamming & Green water

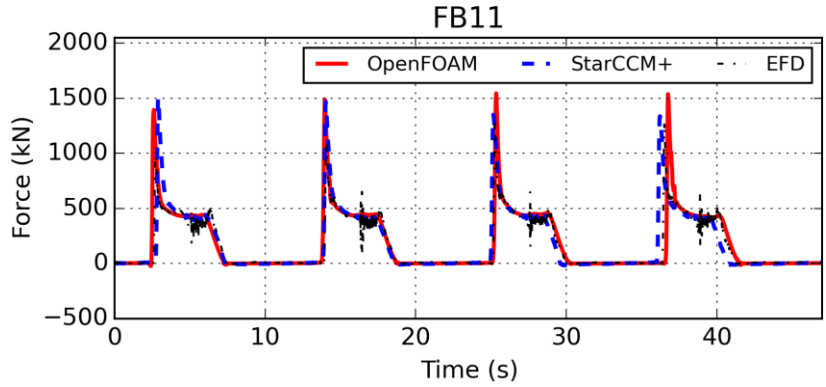
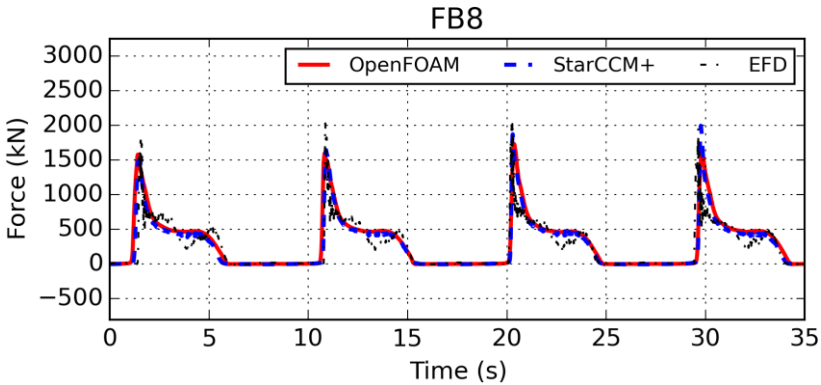


Experiment



(KRISO, 2014)

CFD



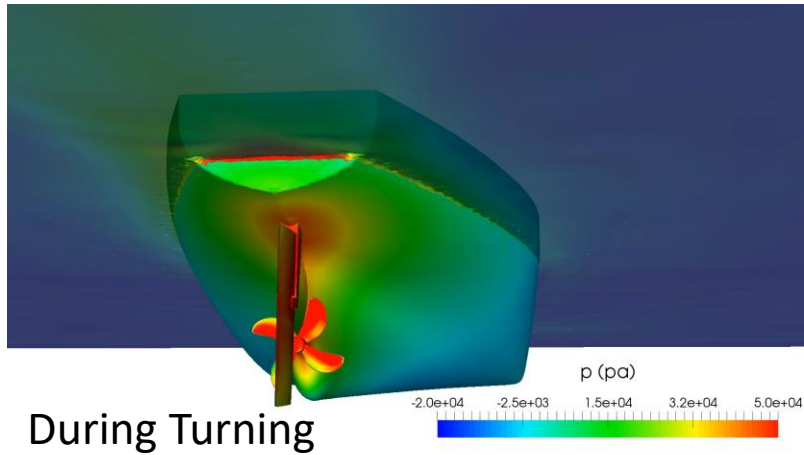
Compared with model test data

KRISO, 2014. Wave Induced Loads on Ships - Joint Industry Project-III. Korea Research Institute of Ships & Ocean Engineering.

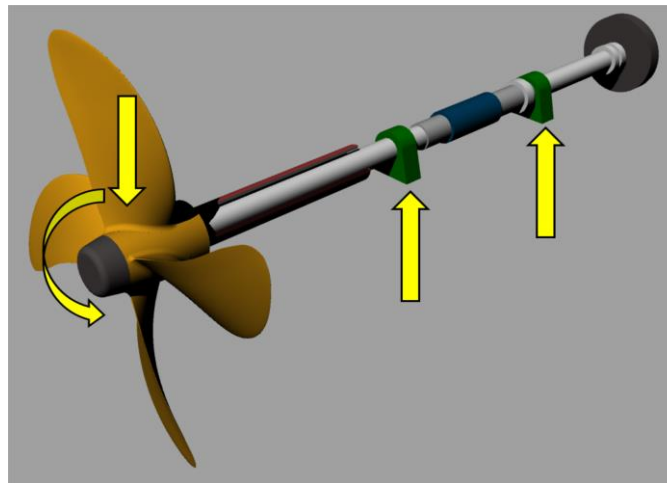
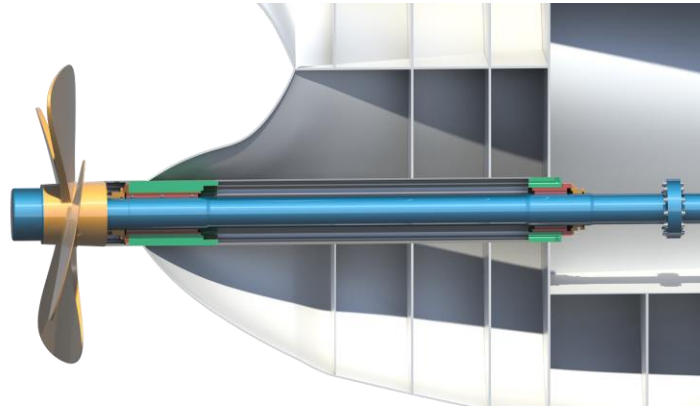


CFD for Shaft Alignment and Optimization

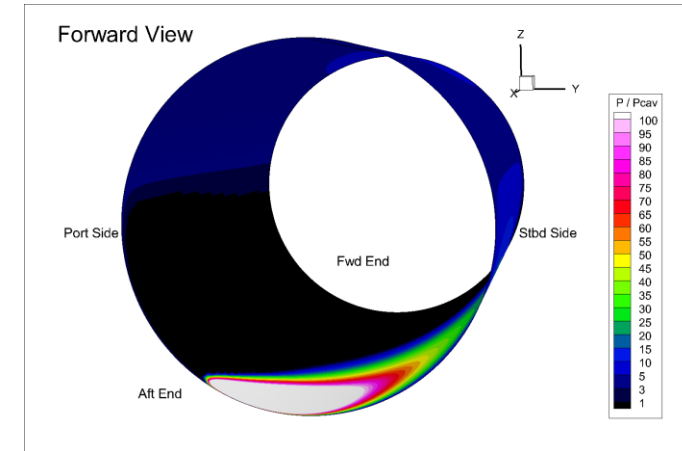
CFD Simulation



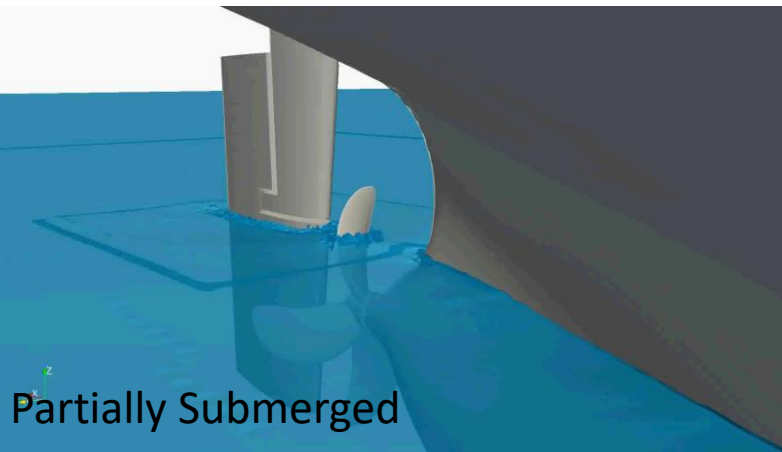
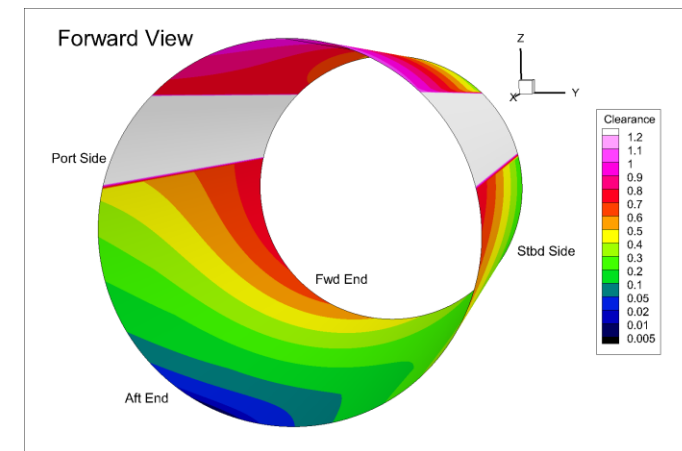
Fluid-Structure Interaction (FSI) Analysis



Oil pressure



Oil film thickness

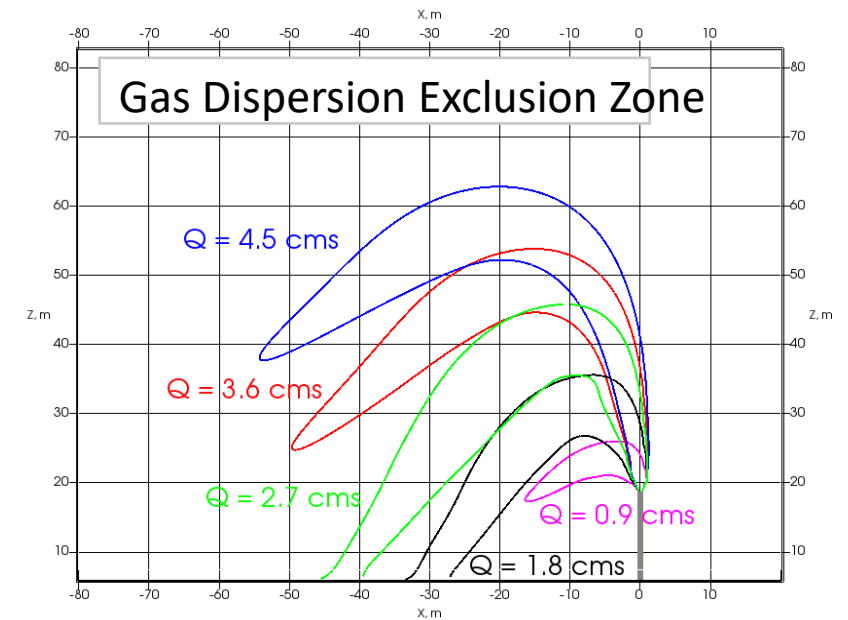


Gas Dispersion

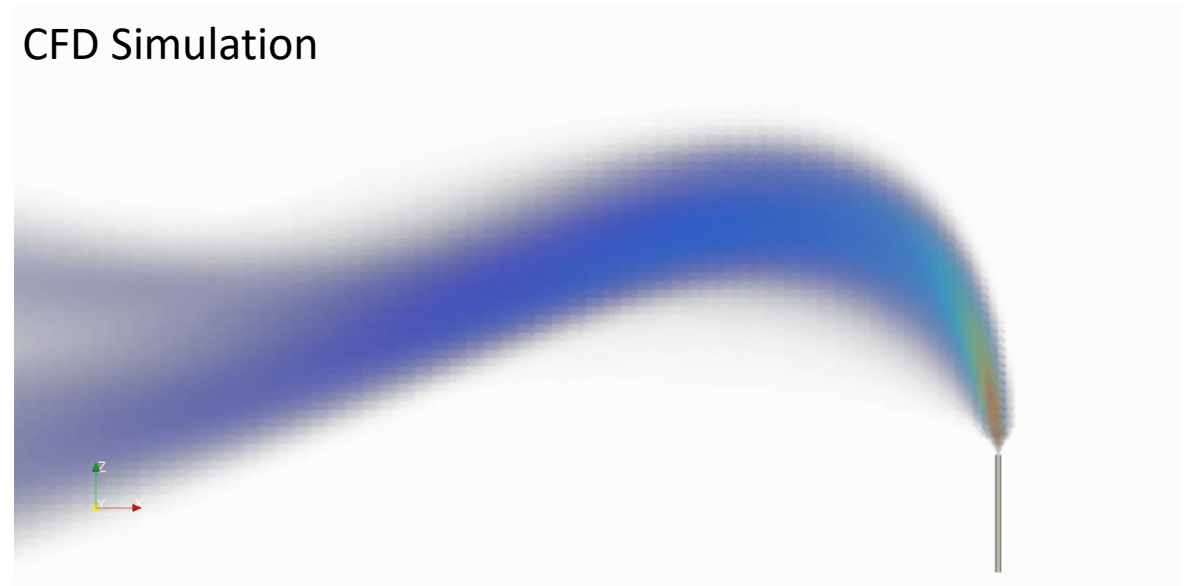
- Gas dispersion analysis of gas venting system
- Develop a Guidance Note on Gas Dispersion Studies of Gas Fueled Vessels



(IMO BLG 14/10, 2009)



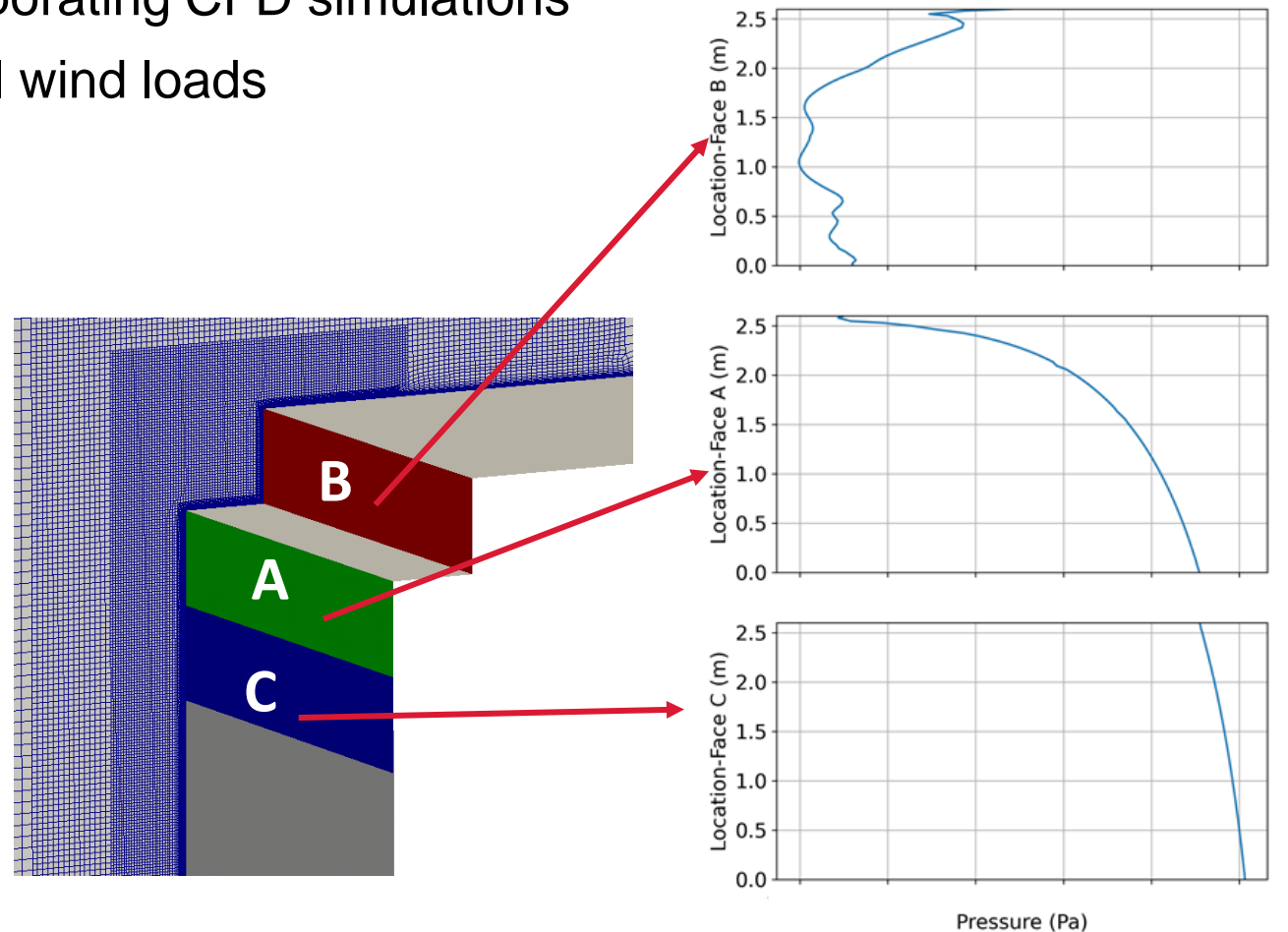
CFD Simulation



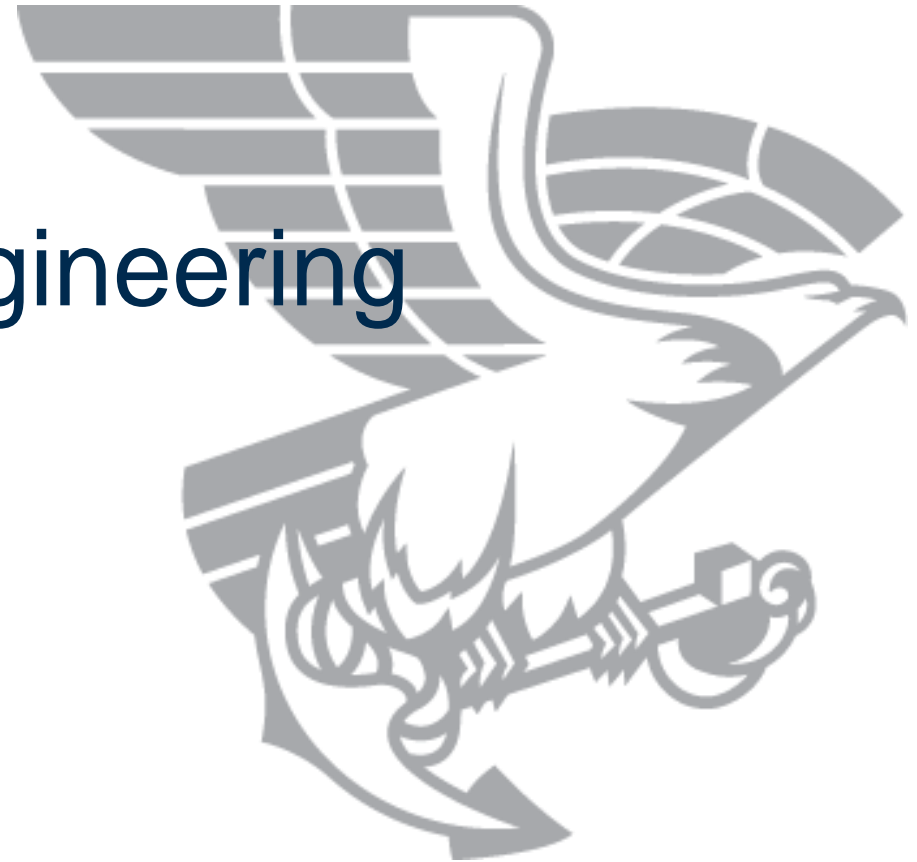
CH_4 , C_2H_6 , C_3H_8 , N_2

Wind Load Estimation on Container Stacks

- To improve wind forces estimation by incorporating CFD simulations
- To estimate partial wind loads instead of full wind loads

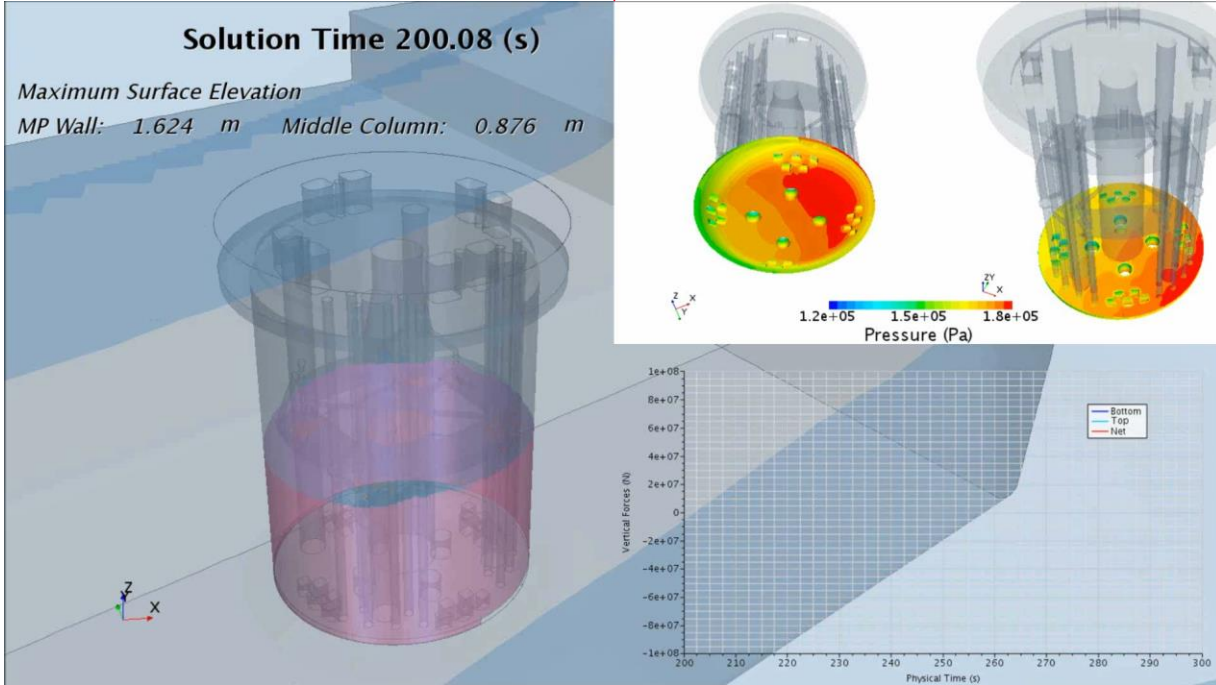
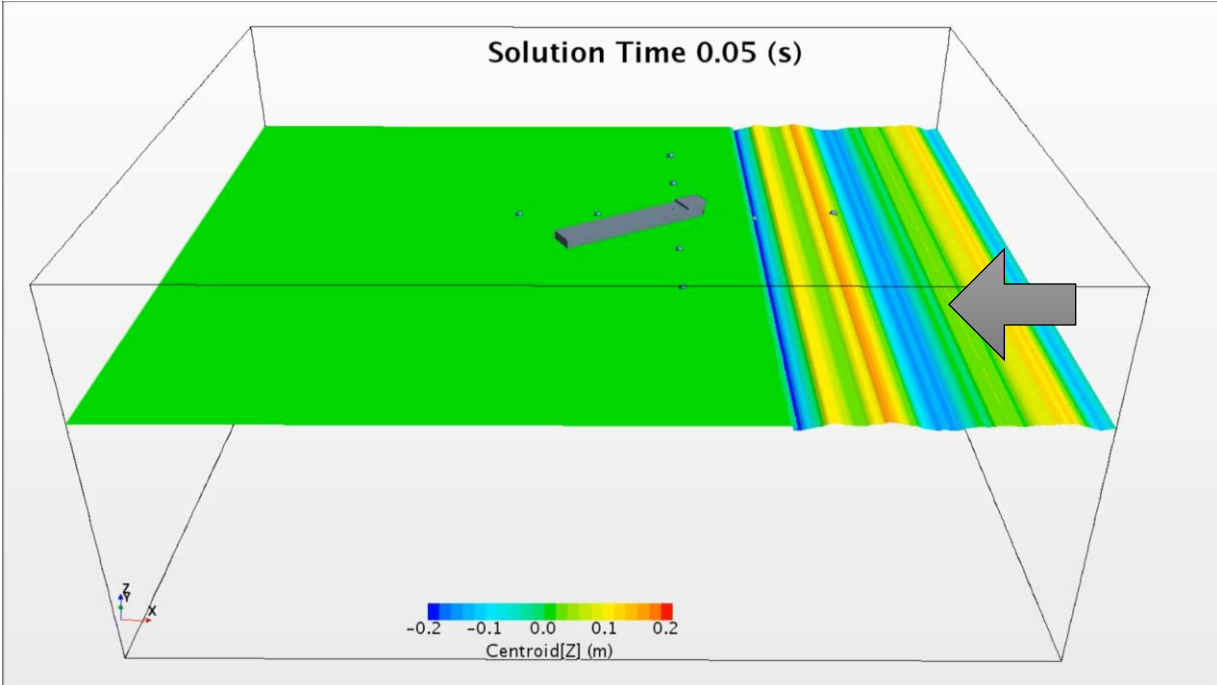
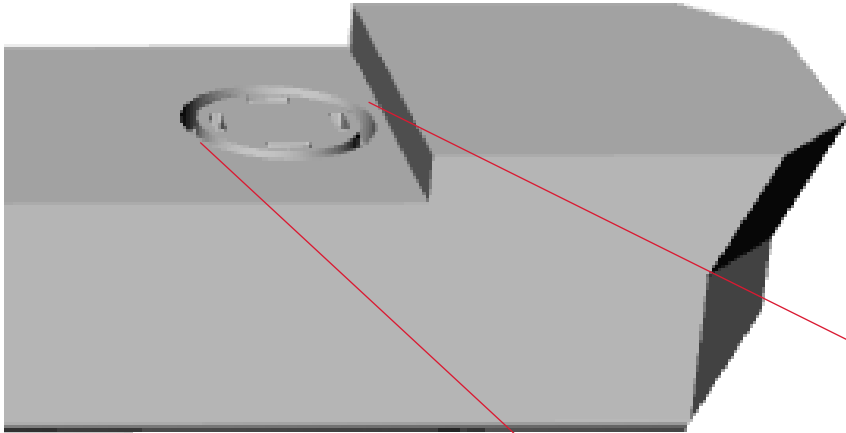


Applications in Offshore Engineering



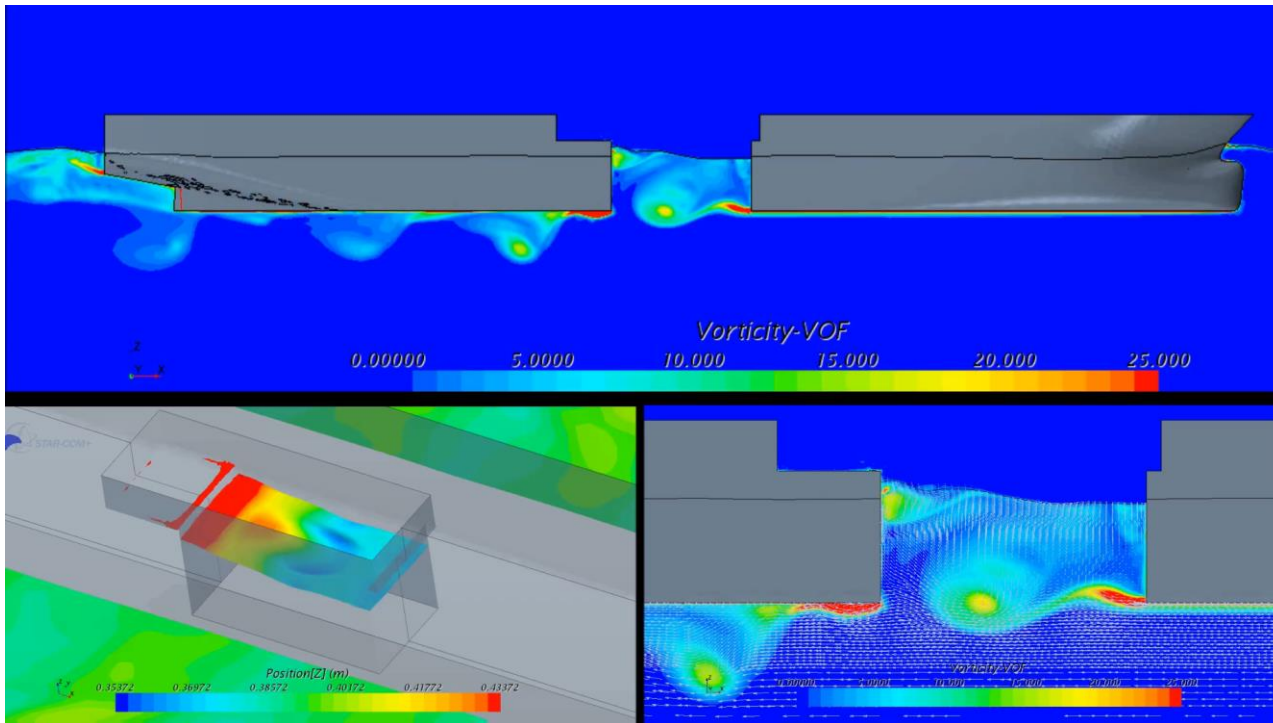
FLNG Turret Moonpool

- Dynamics of moonpool entrapped water
- Dynamic load on moonpool structures

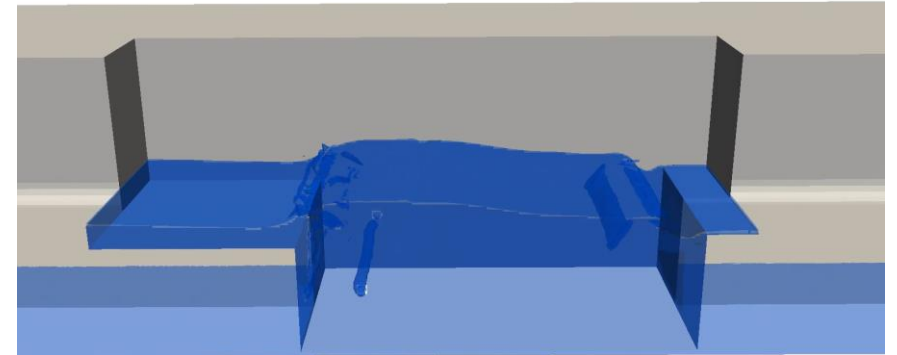


Drillship Moonpool

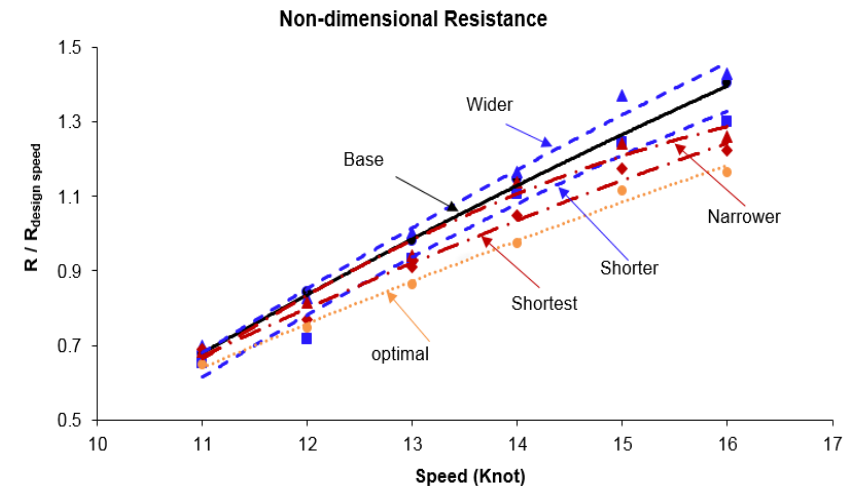
- Added resistance & sloshing impacts
- Effect of moonpool sloshing on stability and impact load on structures and equipment



Sloshing Impacts in Waves

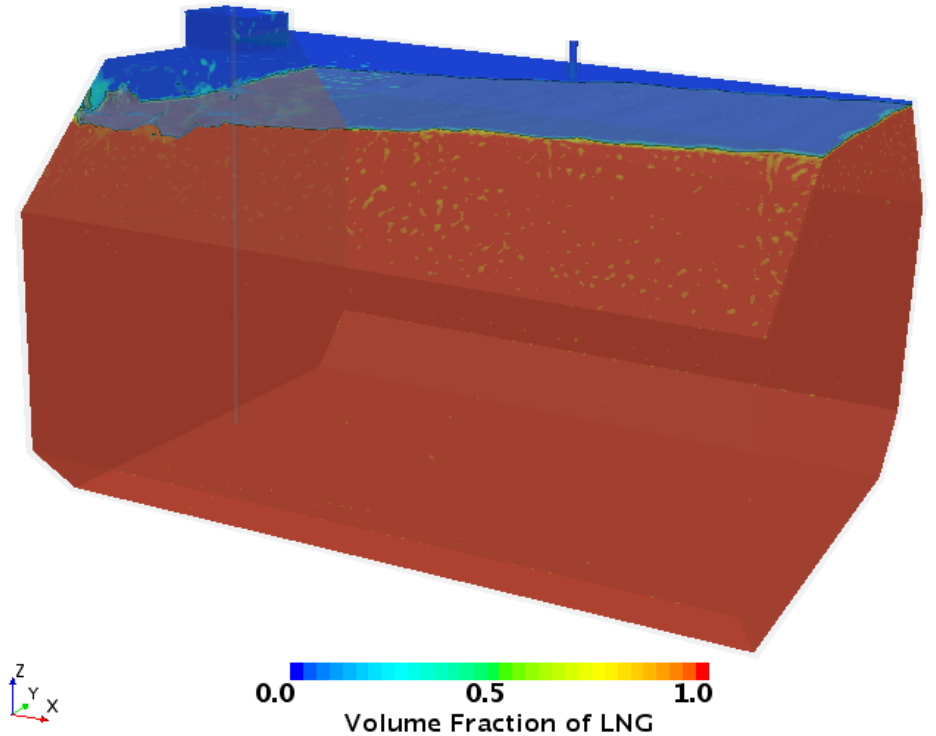


Design and Optimization



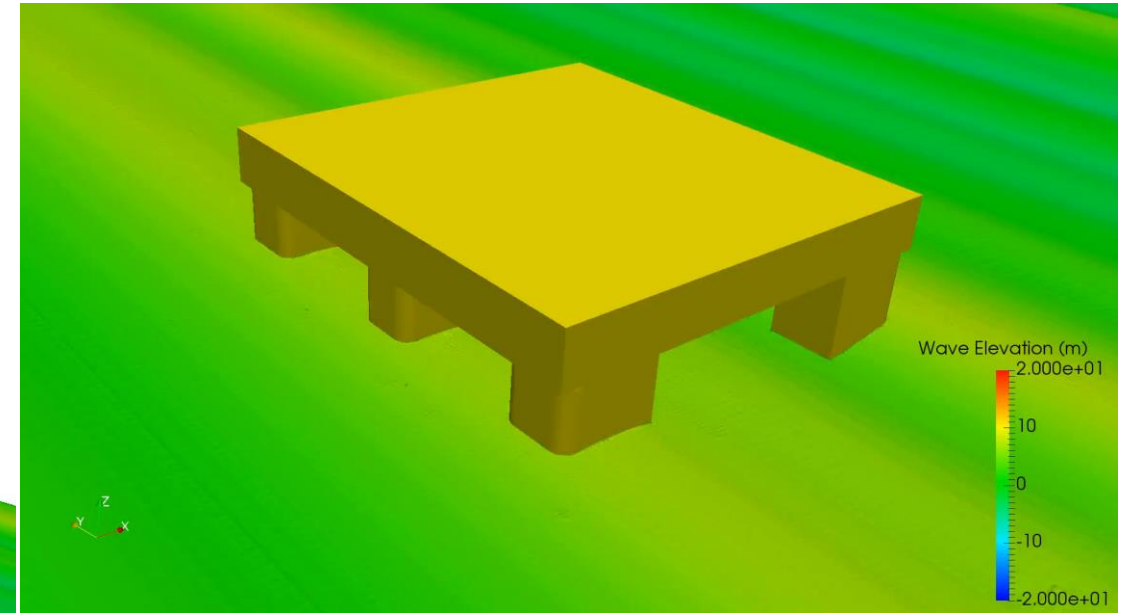
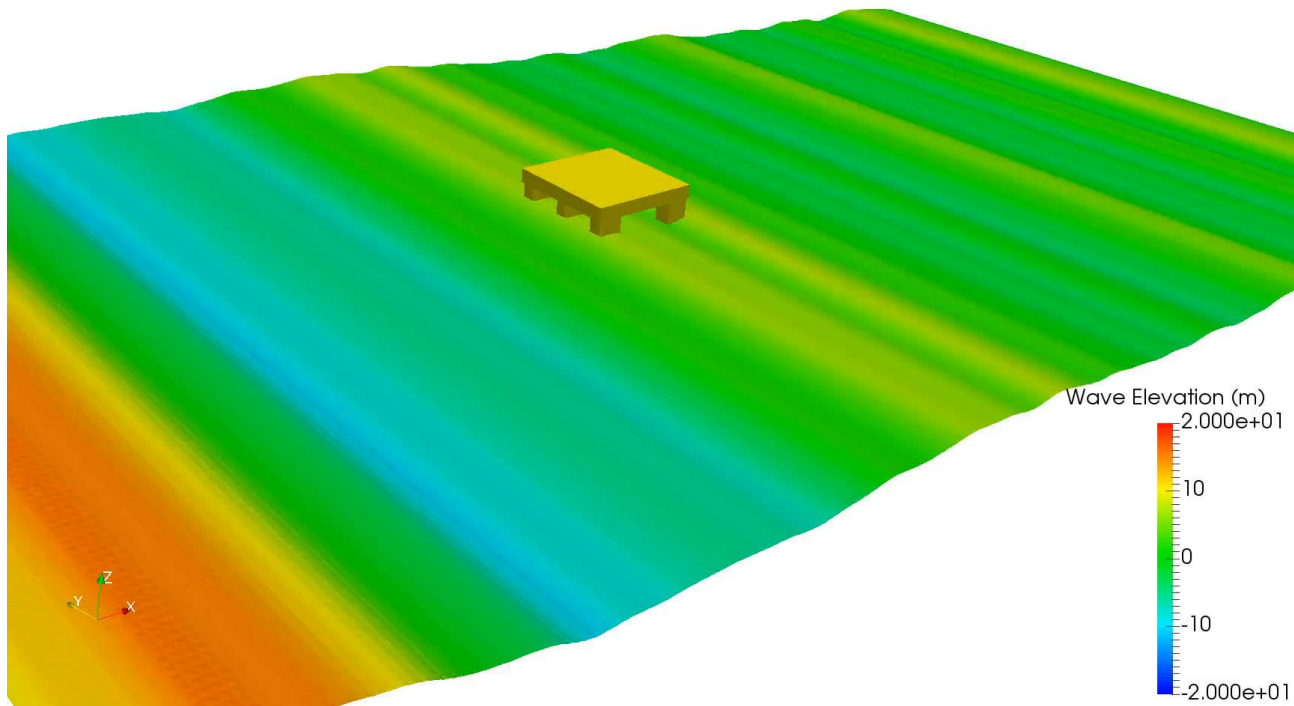
Assessment of LNG Boil-Off Gas (BOG) Using CFD

- Predict LNG BOG rates that account for tank filling operations and sloshing during transit
- Assist designers with selection of insulation
- Assist operators to predict LNG boil-off rate
- Assist port operations determine vent return rate



Airgap and Wave Impact Load Prediction

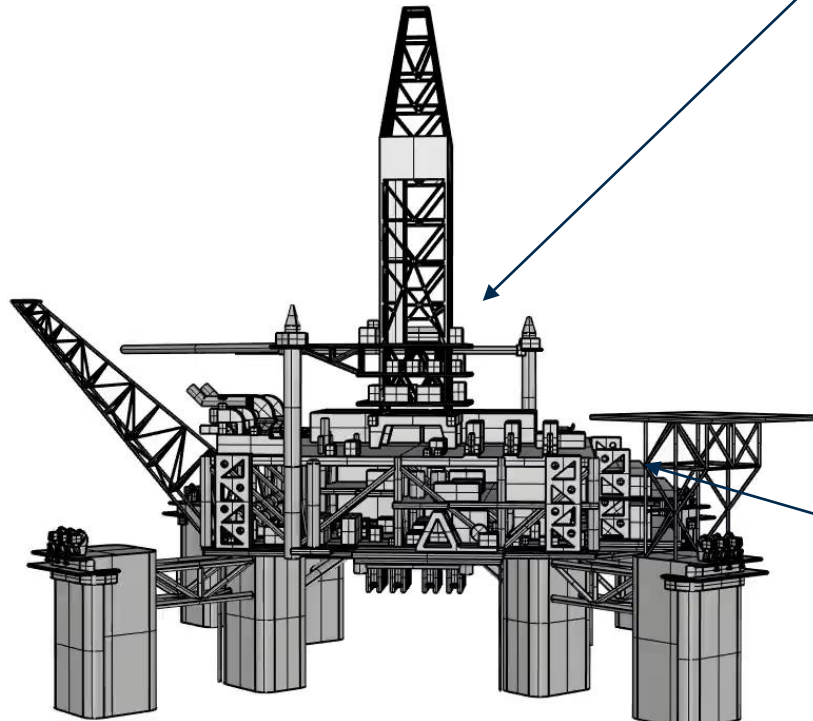
- Refine the airgap and wave impact load calculation methods
- Predict wave asymmetry and run-up factors



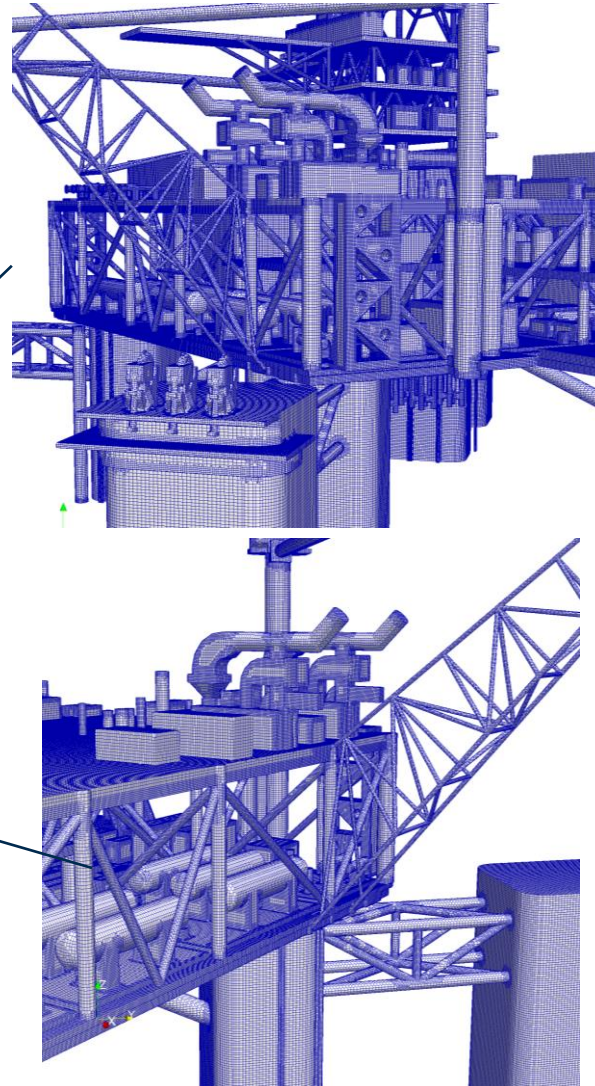
- Long-crest irregular wave
- Screening of 3-hr wave simulation
- Enabled 6 Degree-of-Freedom motion
- Mooring lines included

Wind Load Simulation

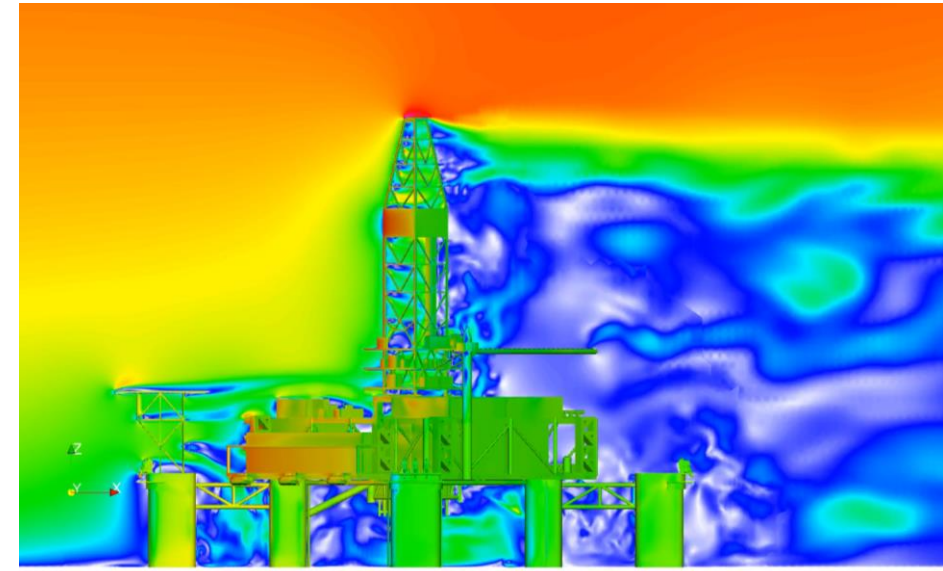
- Higher level of details
- Joint effort in SNAME OC-8 & Reproducible CFD JIP
- Developing industrial guidelines of CFD wind load simulation



Detailed Model of a Semisubmersible



Detailed CFD Mesh



Pressure on semi hull & wake flow

Path Forward

- Challenges remain to make CFD practical for industrial applications
- Through collaborations with the industry and research institutions, CFD technologies will play a more important role in marine and offshore applications:
 - Providing high-fidelity simulations and accurate prediction
 - Supporting design and performance assessment
 - Complementing to sea trials and model basin testing



Thank You

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